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TITLE: THE ROLE OF MILITARY SCIENTISTS AND ENGINEERS IN SPACE (1980-2000)

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ABSTRACT

The Space Transportation System provides military scientists and engineers exciting new capabilities to conduct a variety of pioneering experiments on orbit, taking unique advantage of the space environment itself or observing the planet firsthand from the vantage point of space. The reusable Shuttle/Spacelab configuration permits a more effective use of the human and material resources being committed to the space program in the next decade and ensures the presence of man in space on a routine basis. However, full-scale exploitation of space for national defense will depend to a great extent on the skillful and successful utilization of the military payload specialists, who will fly and operate various Shuttle-based DoD experiments. This paper explores the doctrine, role, function and training requirements for DoD payload specialists. The unique advantage of man-in-the-loop activities and the orbiting military scientist conducting "in-situ" experiments is addressed in light of previous U.S. manned space flight experience and the projected capabilities of the Shuttle.

INTRODUCTION

The Space Shuttle Era gives man the exciting new capability to monitor his planet, its atmosphere and surface conditions in a truly unique way. Weather and climate observations, environmental pollution, atmospheric and ocean dynamics studies, and the effects of energy resources exploitation can now be accomplished by the synergistic grouping of sophisticated remote sensing instruments. Complementing these advanced payloads on a routine basis will be a highly efficient, highly versatile subsystem - man himself![1] Based upon the experiences of Apollo, Skylab and Apollo-Soyuz, there are very distinct contributions manned earth observations can make to an understanding of the planetary climate and the effects of man's activities on it.[2,3,4] A key to the full exploitation of this sophisticated remote viewing of Earth will be the successful use of the payload specialist - the non-career astronaut in space.

Space Transportation System (STS) missions will also include the first manned flights for military research and development experiments and operations in space.[5] One critical factor in the full realization of the Shuttle's great potential for future DoD missions is the creative use of the flight crew itself for interactive "hands-on" operation and control of various payloads. A payload specialist (essentially an engineer, scientist or technical specialist, added to the basic Shuttle crew complement to conduct the experimental portion of the flight program) not only ensures a higher probability of technical success but creates the potential for even greater mission return. To take full advantage of the Shuttle and the payload specialist position, DoD planners must factor use of the military payload specialist directly in the development cycle for new space systems.

The real question facing the Air Force on space in the next few years is not: "Whether military man should be in space at all?" but rather, "How best to use him (or her) effectively?" This, of course, includes the creative use of scientists and engineers on orbit. However, experience in previous U.S. manned space flight programs has also shown that intensive training is essential for success.

Payload specialists can be recruited from the following sources: (1) the military members of the NASA (civilian) astronaut corps; (2) scientist and engineer members of the Armed Services; (3) payload-sponsor organization personnel; and (4) DoD contractors, including staff members of DOE National Laboratories, such as Los Alamos. As DoD executive agency for space, it is incumbent upon Air Force space mission/system planners to examine all of these sources and to create a qualified group of military payload specialists capable of conducting a variety of innovative activities on orbit.

THE MISSION SPECIALIST/PAYLOAD SPECIALIST

The basic Space Shuttle Orbiter crew consists of the commander and pilot, and a mission specialist. Depending on a particular mission's requirements, one or more payload specialists can also be required.[6,7] The mission specialist is a career astronaut proficient in payload/experiment operation. This "permanent" crewmember has a detailed knowledge of payload operations, requirements, objectives and supporting equipment. He or she is knowledgeable about the Orbiter and attached payload support systems and is the prime person for extravehicular activity (EVA) operations.

Finally, the mission specialist is also responsible for the coordination of overall Orbiter operations in the areas of crew activity planning, consumables usage, and other activities affecting payload operations. Under certain circumstances the mission specialist may also perform and also assist in the management of payload operation - at the discretion of the user, and may, in specific cases, serve as a payload specialist.

The payload specialist is the non-career astronaut who flys as a Shuttle passenger and who is responsible for attaining of the payload/experiment objectives. He or she is the on-board scientific expert in charge of the payload/experiment operations. The payload specialist has a detailed knowledge of the payload instruments (and their subsystems), operations, requirements, objectives and supporting equipment. As such, the payload specialist, is the principal investigator conducting his (or her) experiment on-orbit, or at least the direct representative of the principal investigator. Of course, the payload specialist must also be knowledgeable about certain Orbiter systems, such as hygiene accommodations, life support systems, hatches, tunnels, and caution and warning systems.[6,7] The payload specialist will have a particularly good chance of flying in space on Shuttle/Spacelab missions, especially when an operational STS involves many flights per year.

PAYLOAD SPECIALIST POLICY

NASA is currently investigating appropriate policy and processes for determining the selection of payload specialists for those non-NASA payloads to be flown on-board the Shuttle.[8] In this instruction the payload specialist is identified as "an individual selected to operate assigned payload elements on a specific STS flight or mission." Furthermore, the payload sponsor is identified as "the individual or organization who funds for the development and flight of a payload."

The Space Transportation System has been developed to expand this Nation's capabilities to use the benefits of space in a routine, resource-efficient manner. Part of this capability involves the opportunity for on-orbit payload/experiment participation by non-career astronaut investigations. It is current NASA policy, therefore, to provide these selected individuals the opportunity to perform as payload specialist(s) aboard Shuttle flights, conducting measurements, making direct observations, and engaging in activities which support the mission objectives.[8] As currently envisioned by NASA, payload sponsors who contract for the full payload on a particular flight will be allowed the selection and use of two payload specialists - subject, of course to the approval of the NASA Administration. Payload sponsors who contract for at least one-half of the payload on a particular Shuttle flight will be allowed the selection and use of a payload specialist (on a space available basis) - subject, again to the NASA Administration's approval.[8]

PAYLOAD SPECIALIST SELECTION/CERTIFICATION

The process for selecting and training payload specialists is now discussed. Sponsors who have contracted for at least one-half the payload on a Shuttle flight may request resumés of available mission specialists who might have the required qualifications to operate their payloads; or the payload sponsors can propose their own payload specialist(s). If the sponsors elect to nominate their own payload specialists, the nominee(s) must then be approved by the NASA Administrator or his designee. If the payload sponsors have contracted for less than one-half of the payload on a Shuttle flight and, if this payload is determined by NASA to be sufficiently unique and complex to require a payload specialist, then the Director of STS operations will first propose available mission specialists who have qualifications appropriate for the operation of the specific experiment. If none of the available mission specialists satisfies the payload sponsor's requirements, then the sponsor will be requested to nominate a payload specialist(s) who must then be approved by the NASA Administrator.[8]

As part of the overall flight preparation, NASA will identify and negotiate those time periods when the payload specialist(s) must be available for flight independent training. Flight or mission independent training is the flight familiarization training which is required for every mission. Flight familiarization training is to be conducted at the Johnson Space Center (JSC) in Houston, Texas. During this training, the payload specialist will learn how to operate certain Shuttle Orbiter systems, such as food and hygiene subsystems and hatches, and will develop proficiency in the normal and emergency procedures which are required for safe crew operations. NASA will also establish other mission tasks to be accomplished during a flight and allocate those tasks among the available personnel on that flight. Consequently, a payload specialist may be required to participate in on-orbit activities which are not related to his payload.

Payload specialists selected by the payload sponsor or nominated by NASA must be certified in writing as follows:[8]

(1) Passage of NASA Class III physical examination (or military equivalent) at a qualified flight medicine examination facility.

(2) Obtaining a statement of competence (payload/experiment generic) from the payload sponsor.

(3) Obtaining a statement of successful flight independent training completion, and acceptance as to flight readiness by the commander of the Shuttle flight on which the payload is to be flown.

For NASA or NASA-related payloads, the actual selection (by the payload sponsor) of payload specialist(s) is made by a committee known as the Investigator's Working Group (IWG). The IWG consists of the principal investigators or their representatives who have been selected for a particular mission. This committee will formulate the technical requirements for the payload specialists, nominate potential candidates, and select the best candidates. The payload specialists, themselves, will be drawn from the scientific and technical community - domestic or foreign - having a specific interest in the mission. As currently planned, the Investigator's Working Group determines the technical and professional criteria and, from the names, proposed by the principal investigators, nominates and evaluates payload specialist candidates and makes the final selection. The Air Force should develop a similar screening and selection process.

Anyone is eligible to become a payload specialist for NASA or NASA-related payloads, regardless of sex, race, color, age or national origin. Payload specialists may be employed by universities, private industry, or by government agencies (either U.S. or foreign), or even self-employed. In order to eventually fly on a Shuttle mission the payload specialist must ordinarily be proposed by a principal investigator, selected by the IWG, and satisfy NASA's acceptance criteria.

PAYLOAD SPECIALIST TRAINING

A typical training schedule for payload specialists is presented in Figure 1.[7,9] This one year schedule is only representative, however, and for some payloads the sponsor may want to evaluate and screen the payload specialist for longer periods of time before the flight. Figure 2 is a matrix of typical payload specialist training activities with no attempt made to break down the number of hours for each training task. An X indicates that some time is required in the facility and a C indicates coordinated training with at least one STS crewmember present. In general, the training requirement for a payload specialist scheduled for an Orbiter-only flight is approximately 180 hours of training while a flight with a Spacelab pressurized crew module requires about 239 hours.[7]

Payload discipline training consists of individual experiment/payload training. This type of training includes use of the payload sponsor's research facilities, prototype or engineering development payload hardware, and possibly experimental flight hardware. However, there may be specific limitations in the use of flight hardware for training purposes. Payload sponsors must, therefore, evaluate the unique training requirements surrounding their individual payloads, since crew payload training is ultimately the responsibility of such sponsors. Payload discipline training should occur within a time frame that is compatible with the overall Shuttle crew and payload specialist schedules, and may start as early as 2 years before a flight.[7,9]

Flight-independent training for payload specialists involves Shuttle crew functions necessary for any crewperson to perform effectively during the flight. A total of 124 hours of flight-independent training may be anticipated. Payload specialists who have flown before will be required to take a proficiency examination and repeat any such training deemed necessary.

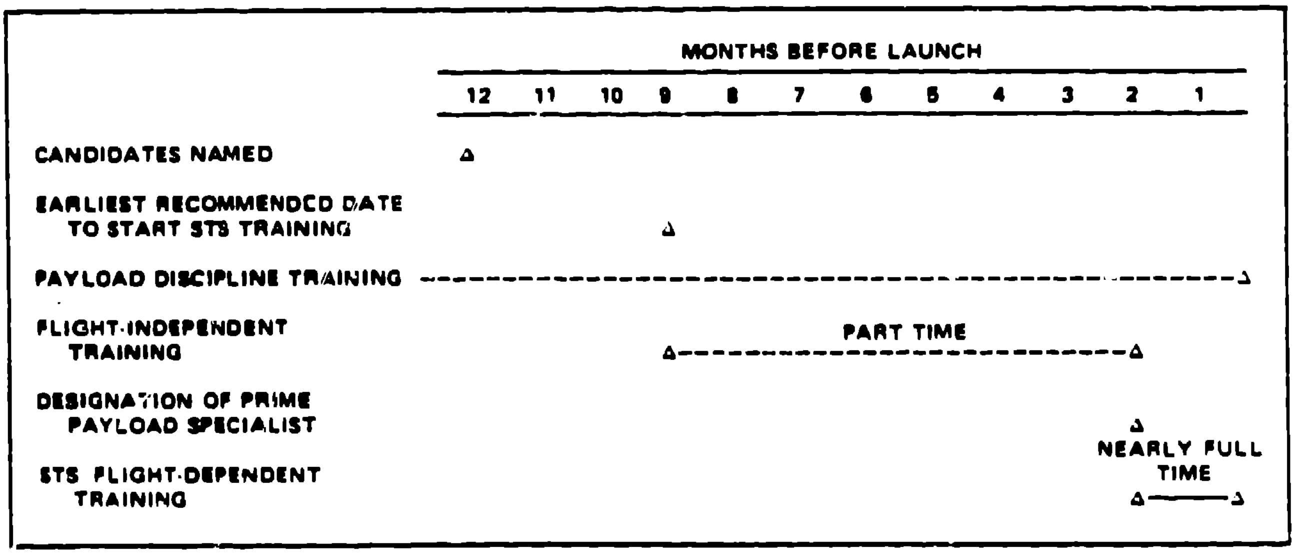
Flight-dependent training can be divided into two categories:

(1) payload discipline training (previously discussed) and

(2) the training necessary to support STS/payload integrated operations.

This latter category of flight-dependent training is characterized by integrated simulations which involve the entire flight crew and groundbased flight operations support team. These integrated simulations, which will occur in one or more of the JSC training facilities, also involve the appropriate Payload Operations Control Center (POCC). Approximately 115 hours will be committed to this type of training.[7]

The two months of "nearly full time" training at the end of the payload specialist training program is a residency period at JSC. About half of this time will be devoted to formalized classroom and simulator training. The remaining time at JSC can be used for STS/payload flight plan integration and reviews, flight/mission rules development and various flight techniques meetings and flight requirements implementation reviews.[7,9] For complex, multi-discipline payloads this type of integrated training may require more than two months.



Typical training schedule for a payload specialist.

FIG. 1 TYPICAL PAYLOAD SPECIALIST TRAINING SCHEDULE

Orbiter habitability

Training type	Facility				Total
	Class	ORB 1-g or SLS	Water tank	Launch pad	
Shuttle Program orientation	X				
STS systems overview	X				
Space flight physiology	X				
Crew systems					
Ingress/egress	X	X		C	
Habitability	X	X			
Stowage	X	X			
Emergency/survival	X	X	C	C	
Medical	X	X			
Crew station activation/deactivation	X	C			
Hours (approximate)	50	45	1	4	100

Orbiter systems

Training type	Facility			Total
	Class	CSTA	ORB 1-g	
Orbiter systems	X		X	
Guidance, navigation, and control/software	X	X		
Ground support network	X			
Hours (approximate)	15	4	4	23

Spacelab habitability (module only)

Training type	Facility		Total
	Class	SLS	
Spacelab crew systems emergency/safety	X	X	
Hours (approximate)	2	3	5

Spacelab systems

Training type	Facility		Total
	Class	SLS	
Electrical power distribution subsystem	X		
Environmental control subsystem	X		
Common payload support equipment	X	X	
Command and data management subsystem	X	X	
Instrument pointing subsystem	X	X	
Hours (approximate)	8	13	21

Integrated crew/ground simulations

Training type	Facility		Total
	ORB 1-g	SMS or SLS	
Ascent		C	
Entry		C	
On-orbit operations	C	C	
Hours (approximate)	10[a]	48	48

[a]The Orbiter 1-g trainer is used in conjunction with the simulators for transfer; therefore this figure is part of the simulator total.

Orbiter phases

Training type	Facility (classroom only)
Orbiter phase training	
crew activity plan and data management	X
Onboard pointing coordination	X
Hours (approximate)	10

Spacelab phases

Training type	Facility (SLS and SMS)
Activation and checkout	C
Orbital operations	C
Deactivation	C
Hours (approximate)	32

FIG. 2 PAYLOAD SPECIALIST TRAINING ACTIVITIES

The flight operations support team is divided into an STS team and a POCC team. To achieve the flight objectives, these teams and the flight crew must function together. Training of each of these teams is conducted separately and then culminates in the crew/ground integrated simulations training. The STS support team is trained through the formal JSC training process. However, for the POCC support team, other than the necessary integrated simulations training there is no STS training required.

PAYLOAD SPECIALIST RESPONSIBILITIES

The payload specialist is responsible for the management and operation of the payload elements/experiments that are assigned to him or her. The payload specialist is also responsive to the authority of the mission specialist and operates in compliance with mission rules and Payload Operations Control Center directives.[7,8,9]

A little more discussion about the role of the mission specialist here will also help clarify the payload specialist's responsibilities. The mission specialist is responsible to the requirements of the payload sponsors and operates in compliance with mission rules and POCC directives. Consistent with responsibilities assigned before the flight and in agreement with the payload sponsor, the mission specialist may also operate experiments or interact with various payloads.[7,8] The mission specialist has prime responsibility for payloads/experiments for which no payload specialist has been assigned, and/or will render assistance to the payload specialist(s) whenever appropriate. Furthermore, when so designated by the payload sponsor(s), the mission specialist will also have the authority to resolve conflicts between payload elements and to approve deviations from the flight plan - when payload equipment failures or other situations occur. Finally, during launch and recovery operations, the mission specialist is also responsible for monitoring and controlling the payload/experiment to assure payload integrity and Orbiter safety.[7,8]

Returning now to the responsibilities of the payload specialist, he or she will be an expert in payload/experiment design and operation, and onboard decisions about detailed payload/experiment operations.

Since the Shuttle is capable of carrying more payloads than personnel to operate payloads, the payload specialist will most likely also be cross-trained as necessary to assist the mission specialist or other payload specialists in payload/experiment operation. However, the payload specialist may not be required to manage payloads/experiments outside of his or her area of expertise.[7] Under certain circumstances, the payload specialist may actually become responsible for all experiments on board. He or she may also operate various payload support subsystems on either the Orbiter or Spacelab in conjunction with payload/experiment operation. These subsystems include an instrument pointing subsystem (IPS), data management and command subsystems, and scientific airlocks. However, the responsibility for the on-orbit management of orbiter systems and attached payload support systems, as well as for extravehicular activity (EVA) and payload manipulation using the remote manipulator system (RMS), rests with the normal Shuttle crew.

DoD SHUTTLE MISSION CATEGORIES

An evaluation of various DoD space mission models[5] has identified four principal Shuttle mission categories for the next few years. These are: (1) payload deployment; (2) sortie or attached payload; (3) retrieval; and (4) assembly. Crew transport and resupply missions between terrestrial bases and permanently manned space platforms must await a national commitment to construct and operate a space station in low-Earth-orbit (LEO).[10]

PAYLOAD DEPLOYMENT MISSION

In a payload deployment mission, the payload is placed on orbit by the Shuttle Orbiter using the remote manipulator system (RMS) to remove the mission equipment (e.g. a spacecraft with or without an orbital transfer vehicle) from the cargo bay and place it in space. This "free-flying" payload is then committed to ground control for further testing, transport to final mission orbit, and operation. For deployment missions, crew and payload specialist functions and tasks are essentially limited to flight readiness and cargo bay removal activities. These functions typically include: (1) attaching the RMS to the payload; (2) releasing retaining clamps; (3) removing the payload from the cargo bay; (4) releasing the payload outside the Orbiter; and (5) turning the payload over to ground control.[5] Special instrumentation in the Orbiter's aft flight deck (AFD) may also be used to run evaluation checks on the deployed payload.

SORTIE MISSION

In a sortie mission, the Orbiter itself is used as a spacecraft, providing stabilization, power, thermal control, telemetry, etc... to the attached payload. Sortie missions of between 7 and 30 days duration are anticipated.[5,7,9] For Shuttle missions involving captive or attached payloads, payload specialist and crew functions and tasks require a greater degree of technical knowledge and skill than payload deployment missions. The "brassboard" protoflights of new military space equipment represents one of the greatest potential applications of the Shuttle and its ability to accommodate military scientists and engineers as payload specialists. In a sortie mission, the payload specialist would be required to function as operator, analyst, and even repairman for the payload.[5,7] Typical activities for the military scientist or engineer on orbit include: (1) initialization of the experiment or protoflight equipment; (2) calibration; (3) target location; (4) optimization of operations; (5) real time evaluation and analysis of data; (6) coordination with investigators on the ground; (7) powering down and stowing for reentry; and (8) maintaining, repairing, and modifying the equipment as appropriate. Since the Orbiter functions as a spacecraft during sortie missions, close interaction with the crew will be required, especially at critical mission times.

RETRIEVAL MISSION

A retrieval mission involves the recovery of an orbiting space system. This requires a rendezvous and docking operation. The "retrieved" system may either be captured and returned to Earth or repaired, refurbished and serviced on orbit and then returned to operation. Each retrieval mission entails similar tasks and functions. These include: (1) rendezvous and docking maneuvers; (2) acquisition with the RMS; (3) installation in the payload bay; (4) inspection and testing; (5) repair and refurbishment; (6) preoperational activities; and (7) operational deployment or stowing for return to Earth.[5,7] Such retrieval activities would involve all flight crew members and could include extravehicular activities (EVA). Present NASA policy[5,8] limits EVA to the mission specialist and the pilot (second crewmember for EVA).

ASSEMBLY MISSION

An assembly mission would be used for a payload which is too large or complex to be launched as a complete unit. Using manipulators, automatic devices and/or EVA, crewmembers could assemble or construct such a payload on orbit and then commit it to its operational location. The crew functions and tasks needed for assembly on orbit are similar to those involved in a payload retrieval mission. Crew activities would include: (1) EVA; (2) the use of tools (powered and hand); and (3) inspection and preoperational testing.[5,7]

TRAINING PROGRAM/FACILITIES

A training program for DoD payload specialists can be developed based on techniques used in previous U.S. manned space flight programs and those currently employed by NASA and the European Space Agency (ESA) for the Spacelab program.[5,7,9]

The objective of this DoD training program would be to develop a high degree of capability for all mission personnel, including flight crew members, mission control center personnel, and ground support teams.

This payload specialist training effort should consist of both instruction and "hands-on" experience. The instruction program should include scientific and technical lectures, conferences, extensive use of manuals and technical reports, and individual discussions with principal investigators and payload sponsors. Hands-on experience can be obtained by inspecting payload hardware, operating mission equipment, interactive flight simulation, and payload operation and control exercises in the Orbiter vehicle.[5,7,9] Each task and function required of the payload specialist, the remaining flight crew or ground support personnel (e.g. at the POCC) should be fully identified and appropriate training methods and resources developed. The payload sponsor organization is mainly responsible for the definition of such training requirements. However, an Air Force Payload Specialist Program Office (AFPSPO) could also be created to assist in the overall training function and in the certification of military (non-career) astronauts for flight readiness.

There are sufficiently adequate facilities currently available[5,7] to help train DoD payload specialists. However, due to their geographic dispersion and heavy usage by regular STS crew training programs, an organized DoD payload specialist training program is most desirable to avoid schedule conflicts and to guarantee the most efficient use of the current training resources.

The majority of these training resources are located at several NASA and contractor facilities. The Marshall Space Flight Center (MSFC), Huntsville, Alabama, and the Johnson Space Center (JSC), Houston, Texas represent major resources for any DoD payload specialist training program. For example, mission-dependent training for NASA/ESA payload specialists and Shuttle flight crews is now being conducted for the Spacelab One and Two Missions (SL-I, SL-II).

The original MSFC plan for payload specialist training depended heavily upon payload sponsor/principal investigator provided training equipment - with MSFC simulation and training activities planned around low-fidelity mock-ups to simulate timelines. However, the non-availability of flight hardware during Spacelab One training activities identified some major disadvantages of this earlier approach.[5] The current MSFC training program still relies on payload sponsor/principal investigator provided training and hardware, but now includes extensive training at the payload crew training complex (PCTC). (See Fig 3).

There are also extensive training facilities at JSC which are dedicated to mission-independent and mission simulation training for all scheduled STS flights. These facilities are complete, except for the mission-unique hardware and software needed for a particular mission simulation (which are payload sponsor provided). The facilities at JSC should be adequate for mission-independent and crew interactive training activities involving DoD payload specialists.

SORTIE SUPPORT SYSTEM (SSS)

The primary system for use with DoD sortie missions is the Sortie Support System (SSS) now being developed for the Space Test Program (STP)[5] (Fig 4). The SSS consists of the following: (1) the sortie support equipment (SSE) required for mechanical support, electrical power, thermal control, data handling, communications, experiment orientation, computer software, and flight crew interfaces; (2) the support and test equipment (STE) necessary to test, support and maintain the SSE; and (3) the astronaut training equipment (ATE) needed to train flight crews and ground support personnel in the operation of the SSE.

The Sortie Support System permits operation and control of attached DoD payloads by the payload specialist from the Orbiter's Aft Flight Deck (AFD). Although this system is being developed for Shuttle sortie missions, it is also applicable to deployed payloads.

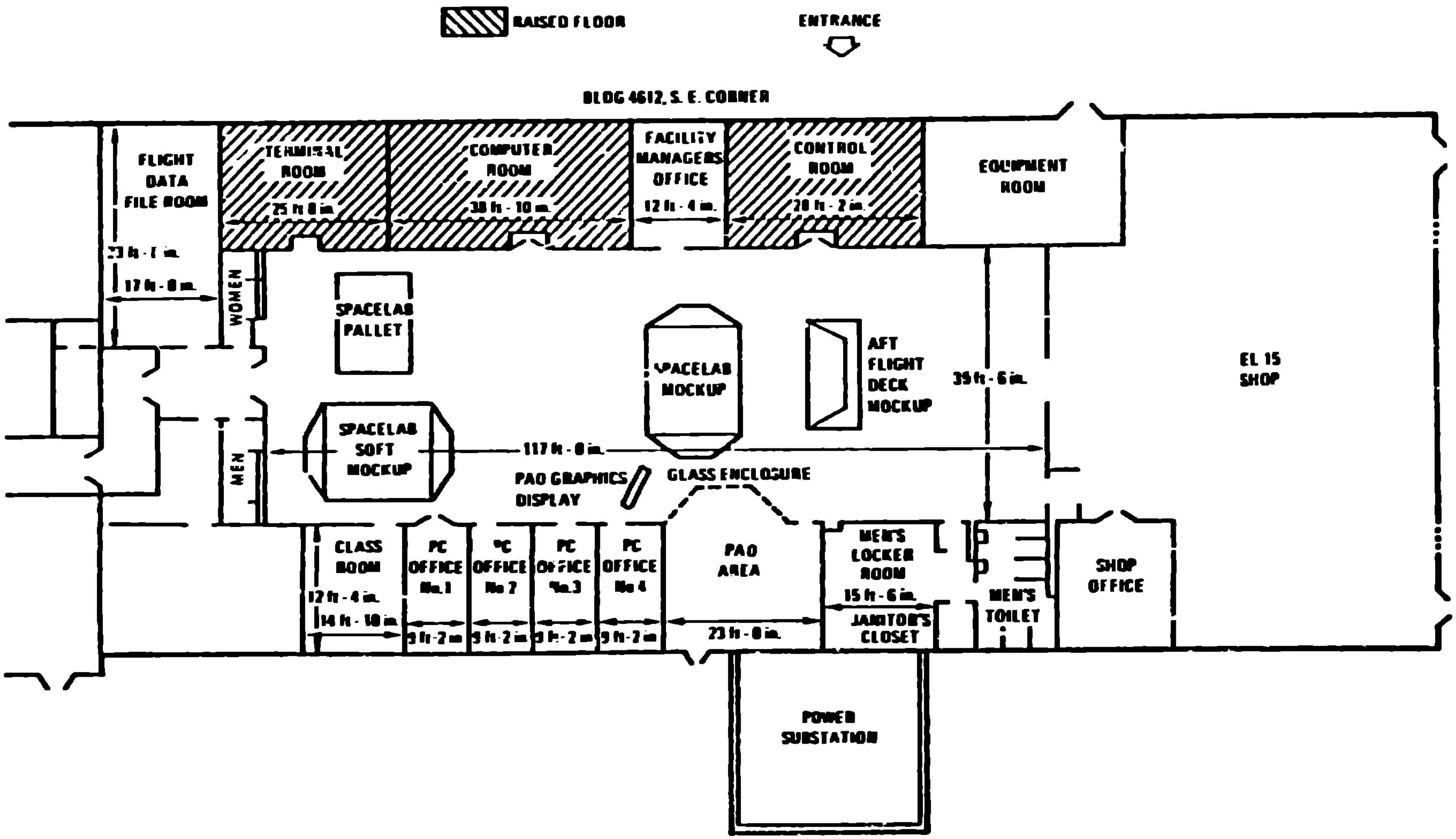


FIG. 3 PAYLOAD CREW TRAINING COMPLEX (PCTC) AT MSFC

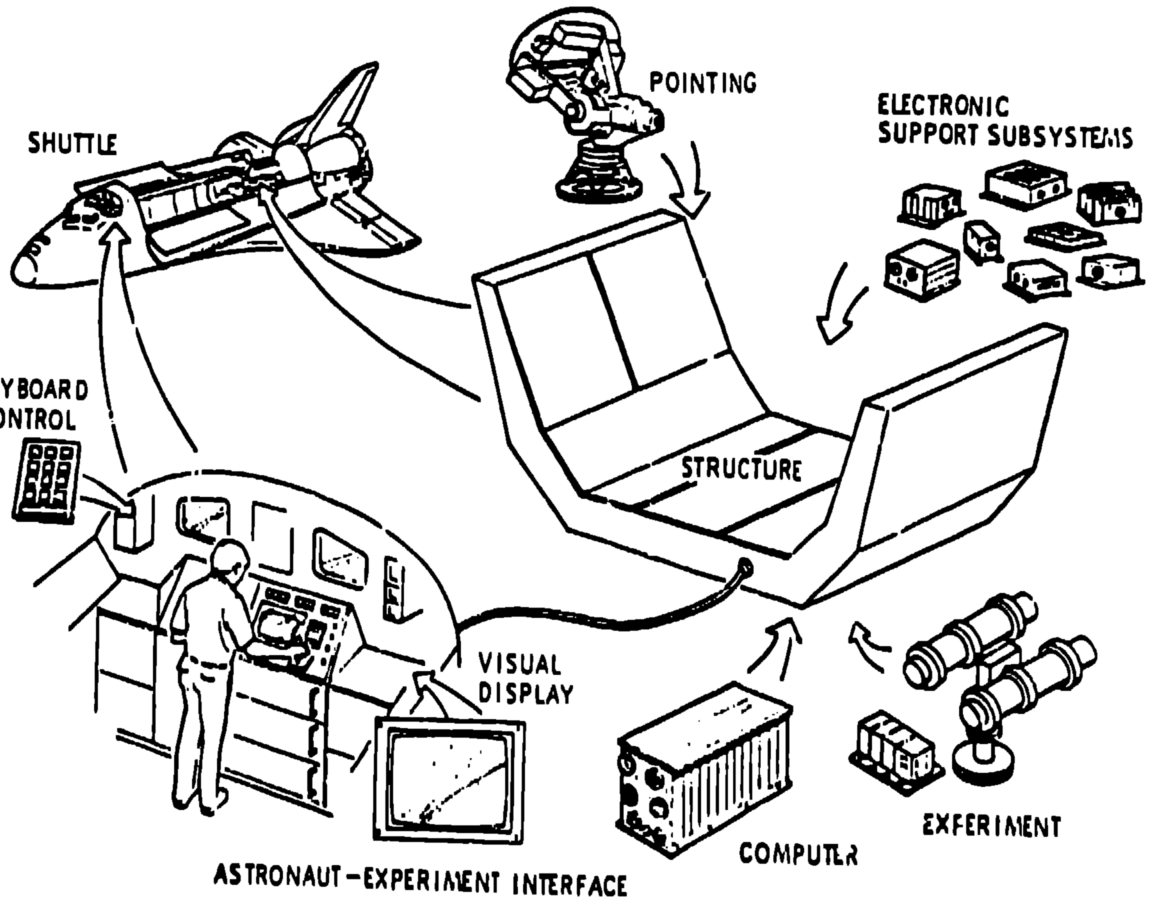


FIG. 4 SORTIE SUPPORT EQUIPMENT (SSE)

MAN'S ROLE IN SPACE

MANNED vs AUTOMATED

Throughout the U.S. Space Program there has been continued discussion about the relative value of "manned" versus "unmanned" missions. In a real sense, the question is essentially one involving the ultimate location of the man (i.e., on the ground or in space), since "automated" payloads are actually controlled by man. It is not the intention of this paper to renew that old debate. Rather, it is sufficient to state here that with the operational Space Transportation System this apparent dichotomy of "manned" versus "automated" missions will vanish.[2,9,11]

The human role in U.S. space flight has gradually expanded through five highly successful manned space programs: Mercury, Gemini, Apollo, Skylab, and the Apollo Soyuz Test Project (ASTP).[12]

PROJECT MERCURY

Project Mercury, the first U.S. manned space flight program was established October 5, 1958, only 5 days after NASA was organized. In Project Mercury, America took its first manned journey into space and learned that man could indeed survive and function normally there.[11,12]

GEMINI PROGRAM

The Gemini Program extended U.S. manned space activity through the development of two-man spacecraft designed for long-duration flights. From March 1965 to November 1966, 10 manned Earth-orbital missions were flown. The Gemini Program demonstrated that man could gainfully live, move about, and work effectively in space. Also techniques such as trajectory shaping and precise maneuvering for spacecraft rendezvous and docking, were developed. These sophisticated techniques were directly used in the Apollo Program.[11,12]

APOLLO PROGRAM

In the late 1960's and early 1970's, America's manned space activity was dominated by the Apollo Program. With the flight of Apollo 8 (December 1968) man first circled the Moon and returned safely to Earth. Starting with the flight of Apollo 11 and man's first step on the lunar surface (July 20, 1969), 12 astronauts explored the Moon. Apollo 17 ended this highly successful program in December, 1972.[12] In the Apollo Program man played useful, often essential, roles in the operation of complex, multipurpose vehicles and in the conduct of sophisticated mission plans. Throughout this program, man continually exercised a high degree of judgement, selectivity and discrimination. Other situations (both planned and unplanned) took advantage of his analytical capabilities, manual dexterity, and ability to respond to the unexpected. Finally, the Apollo Program - through extensive preflight training for lunar surface geology and for lunar observations from orbit - marked the first planned application of man, the scientist, in space! [i.e., Dr. Harrison H. Schmitt (now Senator Schmitt, R-NM) on the Apollo 17 mission][11,12]

SKYLAB PROGRAM

Skylab was America's experimental space station program which became operational in 1973. The Skylab Program expanded our knowledge of Earth-orbital operations and supported the performance of over 50 scientific, technological, and medical experiments. The 100-ton Skylab space station was placed in orbit by a Saturn V rocket, while three three-man crews were carried into space in Apollo spacecraft aboard Saturn 1B rockets. The first Skylab crew remained on orbit for 28 days, the second for 59 days, and the third crew for 84 days. The Skylab missions clearly demonstrated that humans adapt well and can function properly in space for long periods of time - provided they have a proper diet and adequate exercise, sleep, work and recreation.[12]

In Skylab it was clearly demonstrated that:[2,4,9,11]

first - man can function effectively in space for long periods of time.

second - there are many worthwhile experiments, tasks and investigations that can best be accomplished through manned orbital operations.

third - there are beneficial services (planned and emergency) which man can more advantageously perform in space.

APOLLO SOYUZ TEST PROJECT

The Apollo Soyuz Test Project (ASTP) in mid-1975 was a cooperative U.S.- U.S.S.R space mission to test compatible rendezvous, docking and crew transfer systems. Other goals included the performance of space experiments and Earth-observations. Results from the Earth-observation and photography experiment on ASTP demonstrated and confirmed the ability of man on orbit to increase humanity's knowledge about the Earth.[3] ASTP results clearly indicated that a trained astronaut-observer can expertly describe terrestrial features and phenomena (especially transitory), can assimilate and interpret what has been observed (exercising both judgement and recall), and can rapidly select observational targets and/or modify planned activities as needed. Man's unique ability to perform in this manner is a direct complement to Earth-oriented, automated satellite data collection. The Shuttle/Spacelab configuration is a highly versatile continuation of this manned Earth-observation activity.[9,13,14]

SHUTTLE ERA

The previous manned U.S. space programs have successfully demonst ated a variety of roles for man in space.

These roles include:[2,3,4,9,11]

(1) space vehicle pilot,

(2) long-term inhabitant,

(3) payload/experiment manager,

(4) extravehicular activity (EVA),

(5) mission planner and subsystem maintainer,

(6) on orbit scientific investigator (i.e., the "alter ego" of the principal investigator),

(7) on orbit equipment operator and experimenter, and,

(8) on orbit engineer or technician.

In all of these functions and roles man's performance is far superior to that of automated systems.

The role of man in space in the Shuttle Era not only takes advantage of these demonstrated capabilities, but routinely places man in orbit with very flexible, highly complex equipment which will insure an expanded role in data management and interpretation. In typical Shuttle/Spacelab missions the principal investigator himself - as a payload specialist - takes advantages of manned laboratories, observatories and facilities to further exploit space for mankind.[13,14,15] Man the researcher, data integrator, experimenter and systems operator will probe and explore his planet in ways never before possible. In selected Earth observation, for example, the volume of data which must be accumulated, discriminated, reduced and interpreted require man's ability to judge and make decisions.[1,9,11,13] The dynamic range of the human eye and the mind's ability for rapid visual integration of changing geometry, color, shades, hues and lighting represent an extremely versatile "remote sensing system." By combining this system with professional experience and sufficient preflight training - the payload specialist becomes an on orbit resource who:[9,11,13,14]

(1) supports simplifications in instrumentation and equipment designs;

(2) increases overall system reliability;

(3) represents a more resource efficient approach to new instrumentation/equipment development; and

(4) rapidly expands man's ability to detect, observe, understand and predict planetary processes (great and small) which affect all humankind.

SUMMARY

Creative use of the payload specialist by the DoD in the Shuttle Era will accelerate the rate at which space technology and systems directly support the national defense. The effective use of the Shuttle Sortie System (SSS), the careful selection and training of military scientists and engineers for orbital missions and the timely creation of a central Payload Specialist Program Office within the Air Force are all steps to help achieve this goal. Finally, building upon roles and functions demonstrated in early Shuttle missions, DoD Shuttle users of the 1990's will also exploit the payload specialist position in ways not now imagined!

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